WHAT IS CLAIMED:

1. A method of scanning a shaft *in vivo* using a three-dimensional (3D) ultrasound scanner, the method comprising:

scanning an oscillating shaft to provide images including the oscillating shaft *in vivo* in real-time with a real-time three-dimensional (3D) ultrasound scanner.

2. A method according to Claim 1 wherein scanning comprises:

forming transmit ultrasound beams from the real-time 3D ultrasound scanner to the oscillating shaft to provide reflected ultrasound energy from the oscillating shaft;

forming receive ultrasound beams at the real-time 3D ultrasound scanner based on the reflected ultrasound energy from the oscillating shaft; and

providing the images based on data generated from the receive ultrasound beams.

3. A method according to Claim 2 wherein the image data comprises 3D Doppler data, wherein the oscillating shaft is configured to oscillate at an oscillation frequency within an oscillation frequency range, the method further comprising:

filtering the 3D Doppler data using a filter having a center frequency about equal to the oscillation frequency and a bandwidth greater than or about equal to the oscillation frequency range.

4. A method according Claim 2 wherein the data comprises color Doppler data and echo image data corresponding to a location in a scanned volume, the method further comprising:

adjusting the data to attenuate the echo image data and avoid attenuating the color Doppler data at the location in the data.

5. A method according to Claim 2 wherein the data comprises 3D Doppler data and echo image data, wherein providing the images comprises selecting slice image data from the echo image data based on processing the 3D Doppler data corresponding to the oscillating shaft.

6. A method according to Claim 2 wherein the data comprises 3D Doppler data and echo image data, wherein providing the images comprises selecting slice image data from the echo image data that includes a value of the 3D Doppler data corresponding to the oscillating shaft, the value being above a threshold value.

7. A method according to Claim 2 wherein the data comprises 3D Doppler data and echo image data, the method further comprising:

generating a volume rendering of 3D Doppler data corresponding to the oscillating shaft in real-time.

8. A method according to Claim 5 wherein the slice image data comprises first slice image data, the method further comprising:

tracking a tip of the shaft in real-time by selecting second slice image data from the echo image data to provide second slice image data responsive to determining that the second slice image data includes a value of the 3D Doppler data corresponding to the oscillating tip of the shaft that is above a threshold value.

9. A method according to Claim 2 wherein the data comprises 3D Doppler data and echo image data, the method further comprising:

defining a region of interest in the echo image data within which the 3D Doppler data corresponding to the oscillating shaft is generated and outside which 3D Doppler data is not generated.

10. A method according to Claim 9 wherein the region of interest comprises a present region of interest, the method further comprising:

changing the present region of interest to a new region of interest in the echo image data based on the present region of interest and an estimate of a new location of a tip of the oscillating shaft.

11. A method according to Claim 2 wherein the data comprises 3D Doppler data, the method further comprising:

activating oscillation of a vibrator to cause oscillation of the shaft and to enable an audible alarm, and processing of the echo image data to provide 3D

Doppler data responsive to a single user input to the real-time 3D ultrasound scanner, wherein the audible alarm is activated responsive to determining that at least a portion of the 3D Doppler data corresponds to the reflected ultrasound energy from the oscillating shaft.

12. A method according to Claim 2 wherein the data comprises 3D Doppler data, the method further comprising:

activating an audible alarm responsive to determining that at least a portion of the 3D Doppler data corresponds to the reflected ultrasound energy from the oscillating shaft.

13. A method according to Claim 5 wherein the slice image data comprises first slice image data, the method further comprising:

tracking a tip of the shaft in real-time by selecting second slice image data from the echo image data to provide second slice image data responsive to determining that the second slice image data includes a maximum value of the 3D Doppler data corresponding to the oscillating tip of the shaft.

14. An apparatus for guiding an interventional device *in vivo* using an ultrasound scanner comprising:

a sheath having a bore therethrough from a proximal portion to a spaced-apart distal portion;

a shaft having a proximal portion and spaced-apart distal portion and configured for insertion into the bore of the sheath;

a vibrator coupled to the proximal portion of the shaft and configured to cause the distal portion of the shaft to oscillate at a shaft frequency; and

an isolator coupled to the proximal portion of the sheath and to the vibrator, the isolator configured to reduce damping of an oscillation of the shaft by the sheath.

15. An apparatus according to Claim 14 wherein the isolator comprises a hollow tube having an open end and an end coupled to the proximal portion of the sheath.

16. An apparatus according to Claim 14 further comprising:

an electrical contact for energizing the vibrator coupled to the isolator to reduce contact between the proximal portion of the shaft and the proximal portion of the sheath.

17. A system for scanning a shaft *in vivo* using a three-dimensional (3D) ultrasound scanner, comprising:

means for scanning an oscillating shaft to provide images including the oscillating shaft *in vivo* in real-time with a real-time three-dimensional (3D) ultrasound scanner.

18. A system according to Claim 17 wherein the means for scanning comprises:

means for forming transmit ultrasound beams from the real-time 3D ultrasound scanner to the oscillating shaft to provide reflected ultrasound energy from the oscillating shaft;

means for forming receive ultrasound beams at the real-time 3D ultrasound scanner based on the reflected ultrasound energy from the oscillating shaft; and

means for providing the images based on data generated from the receive ultrasound beams.

19. A system according to Claim 18 wherein the image data comprises 3D Doppler data, wherein the oscillating shaft is configured to oscillate at an oscillation frequency within an oscillation frequency range, the system further comprising:

means for filtering the 3D Doppler data using a filter having a center frequency about equal to the oscillation frequency and a bandwidth greater than or about equal to the oscillation frequency range.

20. A system according Claim 18 wherein the data comprises color Doppler data and echo image data corresponding to a location in a scanned volume, the system further comprising:

means for adjusting the data to attenuate the echo image data and avoid attenuating the color Doppler data at the location in the data.

21. A system according to Claim 18 wherein the data comprises 3D Doppler data and echo image data, wherein the means for providing the images comprises means for selecting slice image data from the echo image data based on processing the 3D Doppler data corresponding to the oscillating shaft.

22. A system according to Claim 18 wherein the data comprises 3D Doppler data and echo image data, wherein the means for providing the images comprises selecting slice image data from the echo image data that includes a value of the 3D Doppler data corresponding to the oscillating shaft, the value being above a threshold value.

23. A system according to Claim 18 wherein the data comprises 3D Doppler data and echo image data, the system further comprising:

means for generating a volume rendering of 3D Doppler data corresponding to the oscillating shaft in real-time.

24. A system according to Claim 21 wherein the slice image data comprises first slice image data, the system further comprising:

means for tracking a tip of the shaft in real-time by selecting second slice image data from the echo image data to provide second slice image data responsive to determining that the second slice image data includes a value of the 3D Doppler data corresponding to the oscillating tip of the shaft that is above a threshold value.

25. A system according to Claim 18 wherein the data comprises 3D Doppler data and echo image data, the system further comprising:

means for defining a region of interest in the echo image data within which the 3D Doppler data corresponding to the oscillating shaft is generated and outside which 3D Doppler data is not generated.

26. A system according to Claim 25 wherein the region of interest comprises a present region of interest, the system further comprising:

means for changing the present region of interest to a new region of interest in the echo image data based on the present region of interest and an estimate of a new location of a tip of the oscillating shaft.

27. A system according to Claim 18 wherein the data comprises 3D Doppler data, the system further comprising:

means for activating a vibrator to cause oscillation of the shaft and to enbale an audible alarm, and processing of the echo image data to provide 3D Doppler data responsive to a single user input to the real-time 3D ultrasound scanner, wherein the audible alarm is activated responsive to determining that at least a portion of the 3D Doppler data corresponds to the reflected ultrasound energy from the oscillating shaft.

28. A system according to Claim 2 wherein the data comprises 3D Doppler data, the system further comprising:

means for activating an audible alarm responsive to determining that at least a portion of the 3D Doppler data corresponds to the reflected ultrasound energy from the oscillating shaft.

29. A computer program product for scanning a shaft *in vivo* using a three-dimensional (3D) ultrasound scanner, comprising:

a computer readable medium having computer readable program code embodied therein, the computer readable program product comprising:

computer readable program code configured to scan an oscillating shaft to provide images including the oscillating shaft *in vivo* in real-time with a real-time three-dimensional (3D) ultrasound scanner.

30. A computer program product according to Claim 29 wherein the computer readable program code configured to scan comprises:

computer readable program code configured to form transmit ultrasound beams from the real-time 3D ultrasound scanner to the oscillating shaft to provide reflected ultrasound energy from the oscillating shaft;

computer readable program code configured to form receive ultrasound beams at the real-time 3D ultrasound scanner based on the reflected ultrasound energy from the oscillating shaft; and

computer readable program code configured to provide the images based on data generated from the receive ultrasound beams.

31. A computer program product according to Claim 30 wherein the image data comprises 3D Doppler data, wherein the oscillating shaft is configured to oscillate at an oscillation frequency within an oscillation frequency range, the computer program product further comprising:

computer readable program code configured to filter the 3D Doppler data using a filter having a center frequency about equal to the oscillation frequency and a bandwidth greater than or about equal to the oscillation frequency range.

32. A computer program product according Claim 30 wherein the data comprises color Doppler data and echo image data corresponding to a location in a scanned volume, the computer program product further comprising:

computer readable program code configured to adjusting the data to attenuate the echo image data and avoid attenuating the color Doppler data at the location in the data.

33. A computer program product according to Claim 30 wherein the data comprises 3D Doppler data and echo image data, wherein the computer readable program code configured to provide the images comprises computer readable program code configured to select slice image data from the echo image data based on processing the 3D Doppler data corresponding to the oscillating shaft.

34. A computer program product according to Claim 30 wherein the data comprises 3D Doppler data and echo image data, wherein the computer readable program code configured to provide the images comprises selecting slice image data from the echo image data that includes a value of the 3D Doppler data corresponding to the oscillating shaft, the value being above a threshold value.

35. A computer program product according to Claim 30 wherein the data comprises 3D Doppler data and echo image data, the computer program product further comprising:

computer readable program code configured to generate a volume rendering of 3D Doppler data corresponding to the oscillating shaft in real-time.

36. A computer program product according to Claim 33 wherein the slice image data comprises first slice image data, the computer program product further comprising:

computer readable program code configured to track a tip of the shaft in real-time by selecting second slice image data from the echo image data to provide second slice image data responsive to determining that the second slice image data includes a value of the 3D Doppler data corresponding to the oscillating tip of the shaft that is above a threshold value.

37. A computer program product according to Claim 30 wherein the data comprises 3D Doppler data and echo image data, the computer program product further comprising:

computer readable program code configured to define a region of interest in the echo image data within which the 3D Doppler data corresponding to the oscillating shaft is generated and outside which 3D Doppler data is not generated.

38. A computer program product according to Claim 37 wherein the region of interest comprises a present region of interest, the computer program product further comprising:

computer readable program code configured to change the present region of interest to a new region of interest in the echo image data based on the present region of interest and an estimate of a new location of a tip of the oscillating shaft.

39. A computer program product according to Claim 30 wherein the data comprises 3D Doppler data, the computer program product further comprising:

computer readable program code configured to activate a vibrator to cause oscillation of the shaft and to enable an audible alarm, and processing of the echo image data to provide 3D Doppler data responsive to a single user input to the real-time 3D ultrasound scanner, wherein the audible alarm is activated responsive to determining that at least a portion of the 3D Doppler data corresponds to the reflected ultrasound energy from the oscillating shaft.

40. A computer program product according to Claim 30 wherein the data comprises 3D Doppler data, the computer program product further comprising:

computer readable program code configured to activate an audible alarm responsive to determining that at least a portion of the 3D Doppler data corresponds to the reflected ultrasound energy from the oscillating shaft.